

Phenology Monitoring

National Park Service
U.S. Department of the Interior

Great Smoky Mountains National Park



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What is Phenology?



Phenology is the study of recurring plant and animal life cycle events, or phenophases, such as leafing and flowering, emergence of insects, and migration of birds. These events are critical to many aspects of human life – such as agriculture, gardening, health, cultural events, and recreation—and nearly all ecological relationships and processes. Regular observation of plant and animal phenology helps us better understand the ecology of an area, as well as helping us understand plant and animal responses to changes in our climate.

What are the Phenological Concerns?

One of the longest and best studied phenomenon in the park is the blooming of wildflowers and the leafing out of trees in the spring. While not as well documented, the timing of fall tree colors also is of importance to most park visitors. The Great Smoky Mountains Institute at Tremont has been tracking first bloom dates for wildflowers, migrating birds and amphibians in Walker Valley for over 30 years. Several research studies in other areas, as well as a review of Tremont's data, shows that spring seems to be arriving earlier than it has in the past.



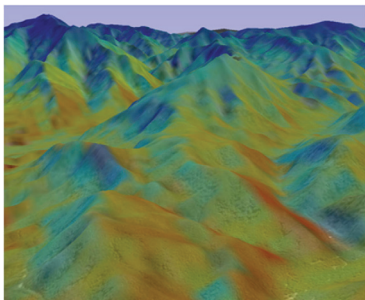
Mistiming between pollinator emergence and the flowering time of the plants they pollinate is one of the concerns in the Park.

While the shift in spring and fall timing of plants is remarkable in and of itself, the impact these shifts will have on the larger ecosystem is of great concern. These shifts are likely to result in mistimings within ecological relationships. Food availability, pollinator availability, and weather damage are all potential results of these mistimings. For instance, in 2007 we experienced early warm weather followed by a prolonged hard freeze that resulted in dead canopy foliage throughout the lower elevations in the park.

Annual flowers, like the Fringed phacelia (seen left), are more likely to be sensitive to climate changes whose strategy is (in part) to survive changing conditions, whereas an annual may be quicker to adapt to changing conditions.

In addition to changes within existing plant communities, it has been predicted that the composition of the communities themselves may change, as organisms respond to climate change by shifting their range either to the north or to higher elevations. Such range shifts have already been recorded in insects, birds, plants and many other groups of organisms. In the Smokies, it is possible that species may shift around a mountain, to a cooler facing slope as well as up in elevation.

Dr. Jason Fridley's temperature map of the Smokies in July (see image left) shows that temperature can vary by as much as 4° C when traveling around a mountain slope. This is the equivalent to moving a 1,000 feet in elevation. These mountain nooks and crannies may provide refuge for certain plant and animal species. Studying phenology in key locations in the park will help us to recognize subtle shifts from sunny, SW facing slopes to cooler, NE facing one.



Dr. Jason Fridley's temperature map.

What Phenology Will Be Studied in Great Smoky Mountains National Park?



Specific phenomena (e.g. peak flowering dates, spring tree green up and fall color, salamander abundances, bird arrivals, etc.) of interest will be actively monitored at designated sites by park staff, citizen scientists, and/or education groups. Ideally, these will ultimately be tied into monitoring done by remote sensing, such as cameras or ambient sound recorders on a larger scale so that we can correlate observations on these two methodologies. Further, these observations would be tied into existing and future remote sensing programs, such as satellite-based green-up measurements, so that phenomena of interest can potentially be modeled across the park.

Automated monitoring at long-term monitoring plots being established within the park ideally would include daily images of wildflower plots to record bloom up and die-back patterns, daily recording of 15 minutes of ambient sound to document arrival of birds, amphibians etc., along with environmental data (e.g. temp, humidity, soil moisture, etc.).

Important Questions Relating to Phenology in Great Smoky Mountains National Park



General questions guiding the parks interest in phenology:

- 1) What is the natural phenological variability of key resources ?
- 2) How closely linked are changes in individual physical climatic attributes (temperature, precipitation in all its forms, relative humidity and solar energy received/area), to specific phenological development, in different resource groups?
- 3) What are the most important park resources or ecological processes at risk to phenological change/disruption? (includes vulnerable species, but also exotic species interactions, diseases and over-abundance/non-synchrony of native species)
- 4) Is there predictive value in phenological monitoring, either for those resources measured or ecologically linked, or for predicting categories of resources at increased risk to phenological disruption?
- 5) Can a phenological monitoring system be designed that fulfills needs at several scales, including local site(s), park wide, regional, global ?

Some sub-questions include:

- What is the upslope or around slope rate of vernalization?
- What species will help us understand how the entire species assemblage is changing? Do we try to identify target species to monitor? If so, which ones?
- Where are the best places to monitor?

How Can Park Visitors Assist?



Visitors could be instructed to take photos from certain overlooks in the park and upload them to a website so we can monitor spring green-up and fall colors.

Visitors can assist us in data collection through participation in ranger -led phenology programs (public and curriculum-based education) or by signing up as a phenology volunteer. Initially, we are testing field monitoring techniques and fine tuning our datasheets at the following locations:

- ☛ In Tennessee: Sugarlands, Twin Creeks, Great Smoky Mountains Institute at Tremont.
- ☛ In North Carolina: Oconaluftee River Trail, Mingus Mill, Purchase Knob

More sites will be added in the future.

Visitors can also assist by collecting data in their own backyard or nearby natural area and entering the data into the National Phenology Network website.
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